

WHAT IS CLAIMED IS:

1. An electric network simulating method comprising the steps of:

5 defining element cells representing electric functions of a plurality of circuit elements and connection pipes representing wiring lines for connecting the circuit elements, defining an electric network current as the number of particles moving in the connection pipe per unit time, and defining an electric network voltage as the number of particles present in the connection pipe;

10 on the basis of definitions in the defining step, setting beforehand, in units of element cells, a rule for expressing an electric function of each of the circuit elements in accordance with a state of the connection pipe connected to each of the element cells;

15 transferring particles between the element cell and the connection pipe in accordance with the set rule; and

20 simulating the state of the electric network by updating the number of particles passing through a given connection pipe per unit time in the transferring step and the number of particles present in the given connection pipe, and performing transfer and updating processes at least once.

25 2. An electric network simulating method comprising the steps of:

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after setting element cells representing electric
functions of a plurality of circuit elements,
intersection cells representing functions of electric
wiring intersections, and connection pipes representing
connections between the element cells and the
intersection cells, defining a current of an electric
network as the number of particles moving in the
connection pipe per unit time, and defining a voltage
of the electric network as the number of particles
present in the connection pipe;

on the basis of the definitions in the defining
step, setting beforehand, in units of element cells,
a rule expressing an electric function of each of the
circuit elements in accordance with a state of the
connection pipe connected to the element cell, and
setting beforehand, in units of intersection cells,
a rule so that the numbers of particles present in
the connection pipes connected to the intersection cell
are equal to each other and a sum of the numbers of
particles transferred at the intersection cell becomes
zero;

transferring particles between the element cell
and the connection pipe and between the intersection
cell and the connection pipe on the basis of the rules
set in the setting step; and

simulating the state of the electric network by
updating the number of particles passing through a



given connection pipe per unit time and the number of particles present in the given connection pipe in the transferring step and performing transfer and updating processes at least once.

5 3. An electric network simulating method according to one of claims 1 and 2, wherein the setting step includes the step of

10 when a given one of the circuit elements is a current source, setting a rule for extracting the number of particles corresponding to a current value per unit time from one of two connection pipes connected to an element cell expressing the given circuit element and giving the number of particles equal in number to the number of extracted particles to the other one of the two connection pipes.

15 4. An electric network simulating method according to one of claims 1 and 2, wherein the setting step includes the step of

20 when a given one of the circuit elements is a voltage source, setting a rule for making a difference between the number of particles in one of two connection pipes connected to an element cell expressing the given circuit element and the number of particles in the other one of the two connection pipes equal to the number of particles corresponding to a voltage of the voltage source.

25 5. An electric network simulating method

according to one of claims 1 and 2, wherein the defining step includes the step of

when a given one of the element cells has nonlinearity as a function of time, defining the given circuit element as a combination of an element cell for a resistive element and one of an element cell expressing a current source and an element cell expressing a voltage source, the combination expresses linearity equivalent to a behavior of the given circuit element at given time; and

the setting step includes the steps of when a certain one of the circuit elements is a current source, setting a rule for extracting the number of particles corresponding to a current value per unit time from one of two connection pipes connected to an element cell expressing the certain circuit element and giving the number of particles equal in number to the number of extracted particles to the other one of the two connection pipes, and

when a specific one of the circuit elements is a voltage source, setting a rule for making a difference between the number of particles in one of two connection pipes connected to an element cell expressing the specific circuit element and the number of particles in the other one of the two connection pipes equal to the number of particles corresponding to a voltage of the voltage source.

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6. An electric network simulating method according to one of claims 1 and 2, wherein the setting step includes the step of

5 when a given one of the circuit elements has an impedance characteristic discontinuously changing, preparing a plurality of rules for the element cell for expressing the given circuit element and selecting one of the plurality of rules in accordance with the state of the connection pipe connected to the element cell.

10 7. An electric network simulating method

according to claim 5, wherein the transferring step and the simulating step include the step of

15 simulating the state of each element cell at initial time so as to simulate a transient phenomenon of the given circuit element having nonlinearity as a function of time, simulating a behavior of the nonlinear element at an operating point advancing by a shortest time interval, by changing each parameter of a combination of the element cells having functions equivalent to the element cells, and simulating the transient phenomenon by repeating the change in parameter every time the shortest time interval has elapsed.

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8. An electric network simulating method according to claim 6, wherein the transferring step and the simulating step include the step of

simulating a behavior of each element cell at

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initial time so as to simulate a transient phenomenon
of the given circuit element having the impedance
characteristic discontinuously changing, simulating
a behavior of the nonlinear element at an operating
5 point advancing a shortest time interval by executing
the transferring step in accordance with the rule
selected in accordance with the state of the connection
pipe connected to the element cell, and simulating the
transient phenomenon by repeating the simulating steps
10 every time the shortest time interval has elapsed.

9. An electric network simulating apparatus
comprising:

means for defining element cells representing
15 electric functions of a plurality of circuit elements
and connection pipes representing wiring lines for
connecting the circuit elements, defining an electric
network current as the number of particles moving in
the connection pipe per unit time, and defining an
electric network voltage as the number of particles
20 present in the connection pipe;

means for setting beforehand, on the basis of
definitions in the defining means, in units of element
cells, a rule for expressing an electric function of
each of the circuit elements in accordance with a state
25 of the connection pipe connected to each of the element
cells;

means for transferring particles between the

element cell and the connection pipe in accordance with
the set rule; and

means for simulating the state of the electric network by updating the number of particles passing through a given connection pipe per unit time in the transferring means and the number of particles present in the given connection pipe, and performing the transfer means and updating process at least once.

10. An electric network simulating apparatus comprising:

means for, after setting element cells representing electric functions of a plurality of circuit elements, intersection cells representing functions of electric wiring intersections, and connection pipes representing connections between the element cells and the intersection cells, defining a current of an electric network as the number of particles moving in the connection pipe per unit time, and defining a voltage of the electric network as the number of particles present in the connection pipe;

means for setting beforehand, on the basis of the definitions in the defining means, in units of element cells, a rule expressing an electric function of each of the circuit elements in accordance with a state of the connection pipe connected to the element cell, and setting beforehand, in units of intersection cells, a rule so that the numbers of particles present in the

connection pipes connected to the intersection cell are equal to each other and a sum of the numbers of particles transferred at the intersection cell becomes zero;

5 means for transferring particles between the element cell and the connection pipe and between the intersection cell and the connection pipe on the basis of the rules set in the setting means; and

10 means for simulating the state of the electric network by updating the number of particles passing through a given connection pipe per unit time and the number of particles present in the given connection pipe in the transferring means and performing transfer and updating processes at least once.

15 11. An electric network simulating apparatus according to one of claims 9 and 10, wherein the setting means includes

20 means for setting, when a given one of the circuit elements is a current source, a rule for extracting the number of particles corresponding to a current value per unit time from one of two connection pipes connected to an element cell expressing the given circuit element and giving the number of particles equal in number to the number of extracted particles to the other one of the two connection pipes.

25 12. An electric network simulating apparatus according to one of claims 9 and 10, wherein the

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setting means includes

means for setting, when a given one of the circuit elements is a voltage source, a rule for making a difference between the number of particles in one of two connection pipes connected to an element cell expressing the given circuit element and the number of particles in the other one of the two connection pipes equal to the number of particles corresponding to a voltage of the voltage source.

10 13. An electric network simulating method

according to one of claims 9 and 10, wherein the defining means includes

means for defining, when a given one of the element cells has nonlinearity as a function of time, the given circuit element as a combination of an element cell for a resistive element and one of an element cell expressing a current source and an element cell expressing a voltage source, the combination expresses linearity equivalent to a behavior of the given circuit element at given time; and

the setting means includes

means for setting, when a certain one of the circuit elements is a current source, a rule for extracting the number of particles corresponding to a current value per unit time from one of two connection pipes connected to an element cell expressing the certain circuit element and giving the number of

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particles equal in number to the number of extracted
particles to the other one of the two connection pipes,
and

means for setting, when a specific one of the
5 circuit elements is a voltage source, a rule for making
a difference between the number of particles in one
of two connection pipes connected to an element cell
expressing the specific circuit element and the number
of particles in the other one of the two connection
10 pipes equal to the number of particles corresponding to
a voltage of the voltage source.

14. An electric network simulating apparatus
according to one of claims 9 and 10, wherein the
setting means includes

15 means for, when a given one of the circuit
elements has an impedance characteristic discontinu-
ously changing, preparing a plurality of rules for the
element cell for expressing the given circuit element
and selecting one of the plurality of rules in
accordance with the state of the connection pipe
20 connected to the element cell.

15. An electric network simulating apparatus
according to claim 13, wherein the transferring means
and the simulating means include

25 means for simulating the state of each element
cell at initial time so as to simulate a transient
phenomenon of the given circuit element having

nonlinearity as a function of time, simulating a behavior of the nonlinear element at an operating point advancing by a shortest time interval, by changing each parameter of a combination of the element cells having functions equivalent to the element cells, and simulating the transient phenomenon by repeating the change in parameter every time the shortest time interval has elapsed.

10 16. An electric network simulating apparatus according to claim 14, wherein the transferring means and the simulating means include

15 means for simulating a behavior of each element cell at initial time so as to simulate a transient phenomenon of the given circuit element having the impedance characteristic discontinuously changing, simulating a behavior of the nonlinear element at an operating point advancing a shortest time interval by executing the transferring means in accordance with the rule selected in accordance with the state of the connection pipe connected to the element cell, and simulating the transient phenomenon by repeating the simulating means every time the shortest time interval has elapsed.

20 25 17. A storage medium storing a simulation program loaded and activated in a computer device, the program activating the computer device to generate:

means for defining element cells representing

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electric functions of a plurality of circuit elements and connection pipes representing wiring lines for connecting the circuit elements, defining an electric network current as the number of particles moving in the connection pipe per unit time, and defining an electric network voltage as the number of particles present in the connection pipe;

5

means for setting beforehand, on the basis of definitions in the defining step, in units of element cells, a rule for expressing an electric function of each of the circuit elements in accordance with a state of the connection pipe connected to each of the element cells;

10

means for transferring particles between the element cell and the connection pipe in accordance with the set rule; and

15

means for simulating the state of the electric network by updating the number of particles passing through a given connection pipe per unit time in the transferring step and the number of particles present in the given connection pipe, and performing the transfer means and updating process at least once.

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18. A storage medium storing a simulation program loaded and activated in a computer device, the program activating the computer device to generate:

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means for, after setting element cells representing electric functions of a plurality of circuit



elements, intersection cells representing functions of electric wiring intersections, and connection pipes representing connections between the element cells and the intersection cells, defining a current of an electric network as the number of particles moving in the connection pipe per unit time, and defining a voltage of the electric network as the number of particles present in the connection pipe;

means for setting beforehand, on the basis of the definitions in the defining step, in units of element cells, a rule expressing an electric function of each of the circuit elements in accordance with a state of the connection pipe connected to the element cell, and setting beforehand, in units of intersection cells, a rule so that the numbers of particles present in the connection pipes connected to the intersection cell are equal to each other and a sum of the numbers of particles transferred at the intersection cell becomes zero;

means for transferring particles between the element cell and the connection pipe and between the intersection cell and the connection pipe on the basis of the rules set in the setting step; and

means for simulating the state of the electric network by updating the number of particles passing through a given connection pipe per unit time and the number of particles present in the given connection

pipe in the transferring means and performing transfer and updating processes at least once.

19. A storage medium storing the simulation program according to one of claims 17 and 18, wherein
5 the setting means includes

means for setting, when a given one of the circuit elements is a current source, a rule for extracting the number of particles corresponding to a current value per unit time from one of two connection pipes connected to an element cell expressing the given circuit element and giving the number of particles equal in number to the number of extracted particles to the other one of the two connection pipes.

10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 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11005 11010 11015 11020 11025 11030 11035 11040 11045 11050 11055 11060 11065 11070

means for defining, when a given one of the element cells has nonlinearity as a function of time, the given circuit element as a combination of an element cell for a resistive element and one of an element cell expressing a current source and an element cell expressing a voltage source, the combination expresses linearity equivalent to a behavior of the given circuit element at given time; and

the setting means includes

means for setting, when a certain one of the circuit elements is a current source, a rule for extracting the number of particles corresponding to a current value per unit time from one of two connection pipes connected to an element cell expressing the

certain circuit element and giving the number of particles equal in number to the number of extracted particles to the other one of the two connection pipes, and

means for setting, when a specific one of the circuit elements is a voltage source, a rule for making a difference between the number of particles in one of two connection pipes connected to an element cell expressing the specific circuit element and the number of particles in the other one of the two connection pipes equal to the number of particles corresponding to a voltage of the voltage source.

22. A storage medium storing the simulation

program according to one of claims 17 and 18, wherein
the setting means includes

5 means for, when a given one of the circuit
elements has an impedance characteristic
discontinuously changing, preparing a plurality of
rules for the element cell for expressing the given
circuit element and selecting one of the plurality of
rules in accordance with the state of the connection
pipe connected to the element cell.

10  23. A storage medium storing the simulation
program according to claim 22, wherein the transferring
means and the simulating means include

15 means for simulating the state of each element
cell at initial time so as to simulate a transient
phenomenon of the given circuit element having nonlin-
earity as a function of time, simulating a behavior of
the nonlinear element at an operating point advancing
by a shortest time interval, by changing each parameter
of a combination of the element cells having functions
20 equivalent to the element cells, and simulating the
transient phenomenon by repeating the change in
parameter every time the shortest time interval has
elapsed.

25 24. A storage medium storing the simulation
program according to claim 23, wherein the transferring
means and the simulating means include

means for simulating a behavior of each element

cell at initial time so as to simulate a transient phenomenon of the given circuit element having the ~~impedance characteristic discontinuously changing, simulating a behavior of the nonlinear element at an operating point advancing a shortest time interval by executing the transferring step in accordance with the rule selected in accordance with the state of the connection pipe connected to the element cell, and simulating the transient phenomenon by repeating the simulating steps every time the shortest time interval has elapsed.~~

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